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Assessment of the 2001/2002 snow crab (*Chionoecetes opilio*) fishery off southwest Nova Scotia (NAFO Division 4X)

Évaluation de la pêche du crabe des neiges (*Chionoecetes opilio*) du sud-ouest de la Nouvelle-Écosse (Division 4X de l'OPANO)

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ABSTRACT

Six permanent licences and two temporary permits were issued for the 2001/02 snow crab season in 4X. The commercial fishing effort was directed exclusively towards the LaHave area in 2001/02. Total allocation set at 520t was not achieved, but the total landings of 376t represented a 77% increase compared to 2000/01. Landings, average CPUE (15 kg/trap haul) and total effort of 25,000 trap hauls were at their highest level since this fishery started in 1994. At-sea sampling in 2001/02 did not represent the fishery considering that 50% of the landings had occurred before the sampling started.

Two exploratory permits were issued in 2002 to conduct a trap survey. The objectives were to determine snow crab distribution and gather biological information on areas not fully exploited by the existing fleet. The distribution of snow crab was consistent with the distribution of cold water in southwest Nova Scotia (SWNS). Results from the trap survey clearly illustrated that snow crab was mostly distributed in the northern portion, more specifically in the area between LaHave Basin and the near shore. The trap survey in 2002 in Roseway Basin showed no commercial concentration.

The first comprehensive trawl survey was carried out in SWNS in 2002. Due to the lack of a time series, the management of this fishery must still primarily rely on the fishery-related data. This fishery may have reached its potential under current environmental conditions and further expansion is not recommended at this time.

RÉSUMÉ

Six licences permanentes et deux permis temporaires ont été émis dans 4X pour la saison de pêche de 2001/02. L'effort de pêche commercial a été exclusivement dirigé vers la région de LaHave en 2001/02. L'allocation totale de 520t n'a pas été atteint, mais les débarquements totaux de 376t représentait une augmentation de 77% comparés à 2000/01. Les débarquements, la PUE moyenne (15 kg/casier levés) et l'effort total de 25 000 casiers levés étaient à leur plus haut niveau depuis que cette pêcherie a commencé en 1994. L'échantillonnage en mer en 2001/02 n'était pas représentatif de la pêcherie puisque 50% des débarquements avaient déjà été accomplis avant que l'échantillonnage ne commence.

Deux permis exploratoires ont été émis en 2002 pour réaliser un relevé aux casiers. Les objectifs étaient de déterminer la distribution du crabe des neiges et amasser de l'information biologique dans les zones peu exploitées par la flottille actuelle. La distribution du crabe des neiges était consistante avec la distribution de l'eau froide dans le sud-ouest de la Nouvelle-Écosse (SNÉ). Les résultats du relevé aux casiers ont clairement démontré que le crabe des neiges était surtout distribué dans la portion nord, plus spécifiquement dans la région entre le basin de LaHave et la côte. Le relevé aux casiers en 2002 dans le basin Roseway n'a pas démontré de concentration commerciale.

Le premier relevé au chalut compréhensif a été réalisé à SNÉ en 2002. Cependant, dû à un manque de données chronologiques, la gestion de cette pêcherie doit encore se faire à partir des données reliées à la pêche. Cette pêcherie a peut-être atteint son plein potentiel sous les conditions environnementales actuelles et il n'est pas conseillé d'augmenter l'effort en ce moment-ci.

INTRODUCTION

Harvesting of snow crab, *Chionoecetes opilio*, in NAFO Division 4X (Area 4X; Fig. 1), off the coast of Southwest Nova Scotia (SWNS) began in 1994 (Biron et al. 2000). This fishery was managed as an exploratory fishery from 1994 to 2000. Two temporary permits were issued to native bands in the fall of 1999. In the fall of 2000, the four exploratory permits in existence since 1994 were converted into permanent licences and the first official fishing season was set for November 1, 2000 to June 1, 2001. The SWNS snow crab industry felt that better quality crab was caught during the colder months of the year. Only two commercial fishing grounds have been identified in Area 4X: the Roseway Basin area and the region north of LaHave Basin (Biron et al. 2000). Following an initial period with low catch (1994 to 1997), a high concentration of snow crab was found along the NAFO fishing boundary 4W/4X in 1998 and most of the fishing effort shifted from the Roseway Basin area to the LaHave fishing grounds. Landings have been increasing steadily since 1997/98.

This fishery falls under the directives of the developing species policy in use in SWNS since 1998 and follows similar management measures as those of Eastern Nova Scotia (ENS) snow crab fisheries such as: no female retained, snow crab male size greater than 95 mm carapace width (CW), no by-catch allowed, mandatory logbook, 100% dockside monitoring, and at-sea observer coverage.

Fishing season of 2001/02 - In 2001/02, two permanent licences were issued to native bands, therefore bringing the total to six permanent licences. Fishermen were allowed either a trap limit of 60 large traps (conical, 6 feet diameter) or of 145 Japanese traps (conical, 4 feet diameter) and 30 large traps. For the first time in SWNS, a cap of 75 t was imposed on the permanent licences, while two exploratory licences with a combined allocation of 70 t were issued to conduct a trap survey along the near shore area of SWNS and between the two known fishing grounds. Total allocation was therefore set at 520 t in 2001/02 without scientific justification.

Update on the current season (2002/03) – There are 7 permanent licences and 2 temporary permits in SWNS in 2002/03. Permanents were allocated 75 t each and temporaries received 37.5 t each for a total allocation of 600 t. Management measures are the same as in 2001/02.

MATERIALS AND METHODS

Landings, catch rate and effort

Commercial catch rates – Raw data on catches and fishing effort were obtained from the mandatory logbooks that are also used for dockside monitoring. Copies of the original completed logs and the compiled electronic database were obtained from the Statistics Division of the Maritimes Region of the Department of Fisheries and Oceans (DFO). Thereafter, total seasonal landings were obtained from a revised preliminary report

produced by the Statistics Division in late December 2002. The average CPUE of the fleet at year (i) corresponds to the ratio of the total catches from the fishermen's logbooks (y_i) and the corresponding number of trap hauled (th_i) reported only in properly completed logs: $CPUE_i = \sum y_i / \sum th_i$. Total effort (i.e. total number of traps hauls: TH) was estimated from total seasonal landings in the revised preliminary report produced by the Statistics Division (Y_i) divided by average CPUE: $TH_i = Y_i / CPUE_i$.

Sea sampling

Sea sampling was carried out onboard commercial vessels to provide an assessment of the percentage of soft-shelled crabs in the catches and the size structure of crabs caught. Certified observers collected measurements. The total number of male crabs, the position, and depth of the trap were recorded for each randomly-sampled trap, and a sub-sample of 40 crabs was taken randomly for the following measurements: carapace width (CW) and chela height (ChH) using modified vernier callipers (Watson and Wells 1970), carapace hardness (CH) of the right claw using a hardness gauge (Foyle et al. 1989), and carapace condition (CC) (Appendix I; Moriyasu et al. 1998).

Catch composition (% of different categories of crab) was estimated based on carapace hardness (hard or soft), size (legal and sub-legal) and morphometric maturity. New-soft (stage I) and clean crab (stage 2) with durometer readings <68 was considered as a postmolt soft-shelled crab (Moriyasu et al. 1998). The terminology of male maturity phase follows Sainte-Marie et al. (1995). Adult (terminal molt) and adolescent (non-terminal molt) individuals were identified based on the following discriminant function assigning individuals to the correct groups in 99% of cases (for adult males: $Y > 0$), calculated for ENS male snow crab (Biron et al., 1999):

$$Y = 19.775707 \ln (ChH) - 25.324040 \ln (CW) + 56.649941$$

Exploratory trap survey

Two exploratory licences were issued in 2002 to conduct a trap survey. The objectives were to determine snow crab distribution and gather biological information on areas not fully exploited by the existing fleet. There were sixty 10' latitude by 10' longitude grids to be surveyed along the near shore area of SWNS (Fig. 2). Minimum reference points and criteria for the survey were published and potential candidates applied by submitting their specific proposal to conduct the survey (Appendix 2). A committee comprised of DFO staff and industry representatives evaluated proposals and selected 2 candidates.

One selected proposal was allocated 30 t to survey the northern portion of Area 4X (Fig. 2) twice with at least 1 month apart between the two samplings. The other accepted proposal was allocated 40 t to survey the southern portion 4 times with at least one month between each sampling. In both the northern and southern portion, sampling data were collected by observer companies and were not adjusted (weighted). For each sampled trap, the total number of male crabs, the position, and depth were recorded, and all crabs were measured for CW, ChH, CH and carapace conditions (random sub-sample if more than 40

crabs/trap). Eight "Minilog Temperature sensors" (VEMCO Ltd.) were provided to each of the two fishermen. Although temperature data will be sent to Hydrologic Services, DFO-Halifax, for proper analysis, some results are briefly discussed in this document.

Biological sampling

Biological sampling was conducted by DFO technicians in co-operation with a fisherman. Specimens were obtained with a Japanese trap that was modified by using a smaller mesh size in order to retain females and small-sized males. Trap positions were selected by the fisherman. For each trap, the total number of male and female crabs, the position, and the depth were recorded. All specimens collected were transported to the laboratory in Moncton, N.B. The following measurements were taken: CW, ChH, weight (*w*), carapace condition and the hardness of the right claw measured with a durometer, for the males; CW, *w*, the width of the fifth abdominal segment (AW), and the color of the eggs and gonads, for the females.

Snow crab trawl survey

Trawl sampling – A trawl survey was conducted in September 2002 using a chartered 65' stern-trawler. A Bigouden *Nephrops* trawl was used (20 m head line, 27.3 m foot-rope mounted with a 3.2 m long, 8 mm galvanised chain, and mesh size of 80 mm in the wings, 60 mm in the belly and 40 mm in the cod-end: Conan et al. 1994). A systematic random sampling design was used to determine the location of trawl stations. One location was randomly chosen within each 10 minute latitude by 10 minute longitude grid. The duration of each tow varied between 5 to 8 minutes at an average speed of 2 knots. The appropriate length of a tow was determined in 1987 (Moriyasu et al. 1998). *Nephrops* trawl was constructed so that the foot rope digs into the bottom sediment and tows longer than 5 to 8 minutes result in a full load of mud, reduced catchability, and significant net damage. NetMind® sensors monitored net behaviour. A Minilog temperature/depth sensor was added in 2001 to compliment other electronic sensors. The onboard starting point for each tow was decided when the predetermined amount of warp is let out and winch drums were locked, and the trawl touched bottom as monitored by the depth Net Mind sensor. The vessel's speed was kept at 2 knots for the duration of the tow (5 minutes). After towing 5 minutes, the engine was put in neutral, the winches were started, and the tow officially ended. In cases of abnormal net behaviour or damage, a new tow was done. Recorded information for each tow was duration, position at start, mid and end, horizontal opening of the trawl using NetMind®, and water depth. Water depths ranged from 50 to 200 meters. Male crabs were measured for CW, CH, carapace hardness and CC. Size-frequency histograms were standardised to the surface area swept by the trawl. Female crabs were measured for CW and the width of the fifth abdominal segment. The presence and the color of the eggs were also taken.

Estimation of abundance by Kriging – Kriging (Matheron 1970; Clark 1979) was used to estimate biomass and density of different categories crab (Conan 1985; Conan et al. 1988; Conan et al. 1994). Kriging consisted of two procedures: (1) analysing and modelling the covariance between sampling units as a function of distance using a variogram; and (2)

then interpolating the densities of crab in unsampled areas by using the covariance function to assign weights to neighbouring samples. Separate variograms and density estimates were made for each sampling unit. Numbers of crab were converted to biomass using a CW-weight relationship, $W = 1.543 \times 10^{-4} CW^{3.206}$ (Biron et al. 1999). Natural mortality was unknown and not considered for this exercise. The Kriging surface was 3,377 km^2.

Temperature – It has been common practice to attach a temperature probe (VEMCO Ltd.) to the trawl for each tow. Temperature data will be sent to Hydrologic Services, DFO-Halifax, for proper analysis.

RESULTS

Fishery

Logbooks - The commercial fishing effort was directed exclusively towards the LaHave area during the 2001/02 season (Fig. 3). The total allocation set at 520 t was not reached, but the total landings of 376 t represented a 77% increase compared to 2000/01 (Table 1, Fig. 4). Two permanent and one of the temporary fishermen, representing a combined potential quota of 190 t, landed only 44 t. All other participants landed their respective allocation. Compared to the 1999/00 and 2000/01, landings occurred early with 50% of the crab landed within the first 2 months (Table 2). The geographic distribution of the landings by 10' x 10' grids showed that the majority of the snow crab landed was from the grids nearest to shore (Fig. 5). The average CPUE derived from the logbooks was 15.0 kg/th in 2001/02, a 10% increase compared to 2000/01, and was associated with a 61% increase in total effort (Table 1, Fig. 6).

Update for 2002/03 - Landings for the first 12 weeks of the 2002/03 fishing season were estimated at 118 t (Table 3), and all were caught in LaHave Basin area. The average CPUE for the first 12 weeks of the 2002/03 season was 9.9 kg/th, while the total effort was 11,957 trap hauls (Table 3).

At-sea sampling by observers – At-sea sampling for the 2001/02 commercial fishery consisted of 10 trips with 60 traps sampled for a total of 1,259 male snow crab measured (Table 4). Nine of those 10 trips were sampled in March and April 2002 on board the same two vessels. The locations of all traps sampled by the at-sea observer program in 2001/02 are shown in Figure 7.

The catch composition showed that 60% of the measured crabs were commercial-sized adult males compared to 74% in 2000/01. Adolescent males accounted for 15% of the catch and little soft-shell crab was captured (0.2%) (Table 4). The proportion of pigmy males (adult male < 95 mm CW) was 24% in 2001/02. The mean CW was 100.5 mm CW (Fig. 8), a slight decrease compared to the 101.6 mm CW to 103.5 mm CW reported in 2000/01. Distribution by carapace condition categories showed that 97% of the sampled crab were of carapace stage 3 (Fig. 9).

Exploratory trap survey

Northern section - The trap survey in the northern portion was first conducted January 21 to 27, 2002, and covered 31 grids with an average of 5 traps per grid (Fig. 10). The same trap positions were surveyed in March 15 to 26, 2002. Overall, 962 male crabs were captured in January (836 sampled) and 991 in March (824 sampled). An average of 6.5 crabs (± 13.8 Standard Deviation) was caught per trap in January and 6.4 (± 14.4 SD) crabs/trap in March. Density concentration showed a patchy distribution that seemed to follow the
100 m depth contour line. Snow crab were found mainly near shore (Fig. 11).

The overall catch composition showed that 80% of the measured crabs were commercial-sized adult males, varying from 77% in January to 85% in March (Table 5). Adolescent males accounted for 5% of the catch and no soft-shell crab were captured. The proportion of pigmy males averaged 14% during the survey. The mean CW was 104.7 mm (Fig. 12). The overall distribution by carapace condition categories showed that 92% of the sampled crab during the trap survey in the northern portion were condition 3 (Fig. 13).

Southern section – In the southern part, the trap survey was conducted 4 times: January 27 to 28 (27 grids), March 8 to 18 (25 grids), April 18 (27 grids) and May 21 to 24 (30 grids). Fishing positions within a grid changed in each survey (Fig. 10). A total of 126 male crabs were captured (123 were sampled) in all four surveys combined. An average of 0.03 crabs /trap (± 0.2 SD) were caught in January, 2.7 (± 8.4 SD) in March and 0.2 (± 0.6 SD) in April and May. Catches occurred in the Roseway Basin and near shore areas (Fig. 11).

Only 40% of the measured crabs were commercial-sized adult males (Table 5). Adolescent males accounted for 6% of the catch. Over 50% of the crab had a soft-shell, and most of them were adults (Table 5, Fig. 14). Pigmy males represented 55% of the catch. The mean CW was 93.2 mm (Fig. 14). The overall distribution by carapace condition showed that 66% of the sampled crab were of condition 2 and 16% were 3 (Fig. 13).

Temperature distribution from trap surveys and fishery - Temperature data collected in 2002 from the commercial fishery and trap surveys showed that the colder bottom temperatures were encountered along the shore, with the coldest observed in February (Fig. 15). Average bottom temperatures on the LaHave fishing grounds were 1.9°C in February, 2.5°C in March and 2.7°C in April. An average of 3.9°C was reported during the trap survey in March in the northern section and of 6.4°C in May for the southern section.

Biological sampling

The average size of males caught with the modified trap was 71.4 mm CW (n=32) (Fig. 16). All males were undersized adults (<95 mm CW) of carapace conditions 3 and 4 (Fig. 16). The average size of females was 67.4mm CW (n=102) with over 85% being of carapace conditions 3 and 4 (Fig. 16).

Trawl survey

The trawl survey in SWNS comprised 21 trawl stations and was conducted September 22 to 24, 2003. It encompassed most of the fishing grounds in LaHave area (Fig. 17). There were 102 males and 119 females collected and measured during the survey in 2002. The total biomass estimation for commercial-sized adult male was 98 ± 372 t, and was comprised of 13 ± 22 t of soft shell and 85 ± 350 t of hard shell crab. The size frequency histogram of male snow crab showed an irregular distribution (Fig. 18). The population of adolescent ≥56 mm was estimated at 820,000 (± 90%) and adolescent ≥ 76 mm was 111,900 (± 370%), while no adolescent ≥95 mm were captured by the trawl. The majority of the females observed (total female = 2,650,000 ± 98%) were multiparous adult (1,915,000 ± 100%) and immature (925,000 ± 70%). There were few primiparous (335 ± 83%) or senile (298 ± 113%) females observed during the trawl survey in 2002.

DISCUSSION

Fishery

Logbook - Fishermen either landed all the snow crab allocated to them or did very poorly. But overall, landings (376 t), average CPUE (15 kg/trap haul) and total effort (25,000 trap hauls) were at their highest level since this fishery started in 1994. However, average CPUE is not a reliable relative index of abundance for this fishery because CPUEs were affected by factors such as soak time, a change of gear toward bigger traps that continued in 2001/02 and an increase of 'inexperienced' fishermen (5 out of 8 fishermen). Standardisation of the CPUE was not believed possible due to the low saturation point of the Japanese trap and the fact that most fishermen used a mixture of traps for each reported landing (Biron et al. 2002). Comparison of the CPUE between Japanese and large traps of two fishermen in the last two seasons illustrated the difference in saturation for the two gear types (Fig. 19). Japanese traps with their lower saturation point did not seem to adequately reflect the abundance of snow crab on the fishing grounds. This exercise also showed that efficiency (yield) was the same for both trap types during the 2000/01 and 2001/02 seasons. Logbook data did not suggest any stock decline during the 2001/02 season. However, the 2002/03 snow crab season in SWNS had a much slower start compared to 2001/02 with 50% less landings and 60% decrease in the CPUE reported during the first 2 1/2 months of the season. Landings and CPUE may have been affected by bad weather in 2003/03 with strong wind making the gear less effective compared to 2001/02.

At-sea Observers - At-sea sampling in 2001/02 was mostly limited to two vessels that were sampled in the winter months. Although these data are comparable with the sampling that occurred in 2000/01 (in terms of sample size, timing and gear types sampled), it does not accurately represent the 2001/02 fishery considering that 50% of the landings occurred in November and December. The increase observed in the catch composition from 5% adolescent in 2000/01 to 15% in 2001/02 could be a good sign of future recruitment, but may simply reflect a decrease in the number of adults from the previous months fishing.

Not knowing what was there at the beginning of the season makes the interpretation of this information very speculative.

The majority of adult male snow crab sampled during the commercial fishery and the trap survey were of carapace condition 3 with few older carapace stages. Only the biological sampling with its undersized adults and the Roseway fishing grounds seem to have more variation in the distribution of the carapace conditions. This may imply a high rate of removal of legal-sized adults by the commercial fishery.

Trap survey

The trap survey conducted between January and May 2002 clearly indicates that snow crab was mostly distributed in the northern portion, more specifically in the area between LaHave Basin and the near shore. The highest density was observed near the 100 m depth contour with smaller concentrations trailing along that depth towards the Roseway Basin area. No new fishing grounds were discovered. The distribution of snow crab was consistent with the distribution of cold water in SWNS. The trap survey in 2002 in Roseway Basin showed no commercial concentration.

Trawl survey

Very little commercial snow crab was caught during the trawl survey. This resulted in a low biomass estimate with a rather large confidence limit. Indications were that some uncertainties associated with the 2002 trawl survey might result in an underestimation of the biomass. Water temperatures were warm for most of the area surveyed (4 to 9°C), while the coldest bottom temperatures were observed near the coast. It is likely that crabs were distributed outside the area surveyed on the hard rocky bottom and untrawlable near shore area. In general, most of the area surveyed had a hard bottom, and two grids originally selected in the near shore area were abandoned for lack of a trawlable bottom. There is a possibility that the *Nephrops* trawl, constructed so that the foot-rope digs into the bottom sediment, may be performing differently on hard bottom. Nevertheless, the overall picture indicated by the trawl survey was that this stock is very small. It would take more than one year of trawl survey data to establish recruitment and commercial adult trends in SWNS. However, under the current situation, we do not see the need to continue the trawl survey in SWNS.

CONCLUSION / RECOMMENDATION

Distribution of snow crab is currently limited to the Roseway Basin and an area the north of LaHave Basin, but only the LaHave fishing grounds seemed to have been of commercial value for the fishermen in 2001/02. SWNS is at the southern limit of snow crab distribution and environmental conditions such as temperature are not favourable to sustain a large population.

There is limited information currently available to properly assess the stock status of snow crab in Area 4X. This first trawl survey did not produce enough results for stock

assessment purposes. Average CPUE from the fishery will remain uninformative in Area 4X as long as factors influencing it keep changing every year, or until proper standardisation methods can be developed. Therefore, in this context, at-sea observer data are very important. At-sea observer coverage should be, as in ENS, proportional to the progression of the landings with a minimum 10% coverage.

The first comprehensive trawl survey was carried out in SWNS in 2002. Due to the lack of a time series, the management of this fishery must still primarily rely on fishery-related data. This fishery may have reached its potential under current environmental conditions and further expansion is not recommended at this time.

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Table 1. Seasonal landings, catch rate, and effort statistics for Snow Crab (*Chionoecetes opilio*) for southwestern Nova Scotia (Exploratory NAFO 4X), 1994 to 2002.

Season	Active Licences/permits	TAC (t)	Total* landing Statistics (t)	Total mean CPUE (kg/trap haul)	Total Effort (trap haul)
1994/1995	4	-	17	1.8	9,406
1995/1996	4	-	11	1.0	11,146
1996/1997	4	-	4	1.0	3,475
1997/1998	4	-	42	5.3	7,893
1998/1999	4	-	70	11.8	5,986
1999/2000	4	-	119	9.8	12,038
2000/2001	6	-	213	13.7	15,568
2001/2002	8	520	376	15.0	25,017
Average (all)			107	7.4	11,316
Average (99/00-01/02)			236	12.8	17,725

* Total seasonal landing statistics provided by DFO-Statistics, Halifax.

Table 2. Weekly landing, catch rate, and effort statistics for Snow Crab in Area 4X for the 2001/02 season.

2001/2002			
Week	Landings (kg)	CPUE (kg/trap haul)	Effort (total number of trap haul)
Oct. 21	-	-	-
Oct. 28	7,721	42.9	180
Nov. 4	38,622	24.7	1,561
Nov. 11	23,096	28.8	801
Nov. 18	46,672	26.8	1,742
Nov. 25	15,401	59.0	261
Dec. 2	18,831	22.0	855
Dec. 9	21,988	25.2	874
Dec. 16	9,186	15.9	579
Dec. 23	622	9.3	67
Dec. 31	4,807	9.8	490
Jan. 6	12,127	12.6	960
Jan. 13	8,295	11.4	728
Jan. 20	8,829	11.4	775
Jan. 27	18,465	13.3	1,387
Feb. 3	8,915	12.4	721
Feb. 10	10,688	12.3	869
Feb. 17	19,436	13.8	1,408
Feb. 24	17,189	11.7	1,476
Mar. 3	11,437	10.5	1,089
Mar. 10	14,424	12.0	1,199
Mar. 17	7,962	12.7	625
Mar. 24	11,781	9.9	1,188
Mar. 31	10,348	8.6	1,204
Apr. 7	7,523	6.0	1,245
Apr. 14	6,765	8.0	841
Apr. 21	6,456	8.1	800
Apr. 28	2,898	10.4	280
May 5	1,129	6.5	174
May 12	681	2.6	265
May 19	1,957	?	?
Total*	374,251	15.0	25,017

*Total seasonal landings

Table 3. Preliminary report of weekly landing, catch rate, and effort statistics for Snow Crab in Area 4X for the 2002/03 season.

2002/2003			
Week	Landings (kg)	CPUE (kg/trap haul)	Effort (total number of trap haul)
Nov. 3	32,728	14.6	2,235
Nov. 10	31,097	13.1	2,375
Nov. 17	9,196	8.1	1,143
Nov. 24	9,378	18.0	520
Dec. 1	12,305	8.6	1,431
Dec. 8	5,924	5.7	1,041
Dec. 15	3,038	4.2	726
Dec. 22	1,141	8.5	135
Dec. 29	1,969	4.4	448
Jan. 5	7,060	5.8	1,209
Jan. 12	4,356	6.5	675
Jan. 19	123	2.1	60
Total	118,315	9.9	11,957

Table 4. Catch composition, in number and percentage, from at-sea samples (in number of trips and traps sampled) in Area 4X for 2001-2002.

a) Catch composition (in number) in Area 4X.

Coverage		Size	Hard shell crab		Soft shell crab		By maturity stage		Total
Trip	Trap		Adolescent	Adult	Adolescent	Adult	Adolescent	Adult	
10	60	< 95 mm	91	301	0	2	91	303	394
		> 95 mm	99	764	2	0	101	764	865
		Total	190	1065	2	2	192	1067	1259

b) Catch composition (%) in Area 4X.

Coverage		Size	Hard shell crab		Soft shell crab		By maturity stage		Total
Trip	Trap		Adolescent	Adult	Adolescent	Adult	Adolescent	Adult	
10	60	< 95 mm	7.9	23.9	0.0	0.2	7.2	24.1	31.3
		> 95 mm	7.9	60.7	0.2	0.0	8.0	60.7	68.7
		Total	15.1	84.6	0.2	0.2	15.3	84.7	100.0

Table 5. Catch composition by fisherman (in percentage and number) from the 2002 trap survey (number of trips and traps sampled) in Area 4X.

a) Catch composition in January 2002 during the northern area trap survey (%).

Coverage		Size	Hard shell crab		Soft shell crab		By maturity		Total
Trip	Trap		Adolescent	Adult	Adolescent	Adult	Adolescent	Adult	
5	55	<95 mm	0.60	15.77	0.00	0.00	0.60	15.77	16.37
		>95 mm	6.81	76.82	0.00	0.00	6.81	76.82	83.63
		Total	7.41	92.59	0.00	0.00	7.41	92.59	100.00

b) Catch composition in March 2002 during the northern area trap survey (%)

Coverage		Size	Hard shell crab		Soft shell crab		By maturity		Total
Trip	Trap		Adolescent	Adult	Adolescent	Adult	Adolescent	Adult	
3	66	<95 mm	0.85	12.00	0.00	0.00	0.85	12.00	12.85
		>95 mm	2.30	84.85	0.00	0.00	2.30	84.85	87.15
		Total	3.15	96.85	0.00	0.00	3.15	96.85	100.00

c) Catch composition during the northern area trap survey (%)

Coverage		Size	Hard shell crab		Soft shell crab		By maturity		Total
Trip	Trap		Adolescent	Adult	Adolescent	Adult	Adolescent	Adult	
8	121	<95 mm	0.72	13.90	0.00	0.00	0.72	13.90	14.62
		>95 mm	4.57	80.81	0.00	0.00	4.57	80.81	85.38
		Total	5.29	94.71	0.00	0.00	5.29	94.71	100.00

d) Catch composition during the southern area trap survey (%)

Coverage		Size	Hard shell crab		Soft shell crab		By maturity		Total
Trip	Trap		Adolescent	Adult	Adolescent	Adult	Adolescent	Adult	
5	14	<95 mm	0.81	30.89	0.81	23.58	1.63	54.47	56.10
		>95 mm	0.81	14.63	3.25	25.20	4.07	39.84	43.90
		Total	1.63	45.53	4.07	48.78	5.69	94.31	100.00

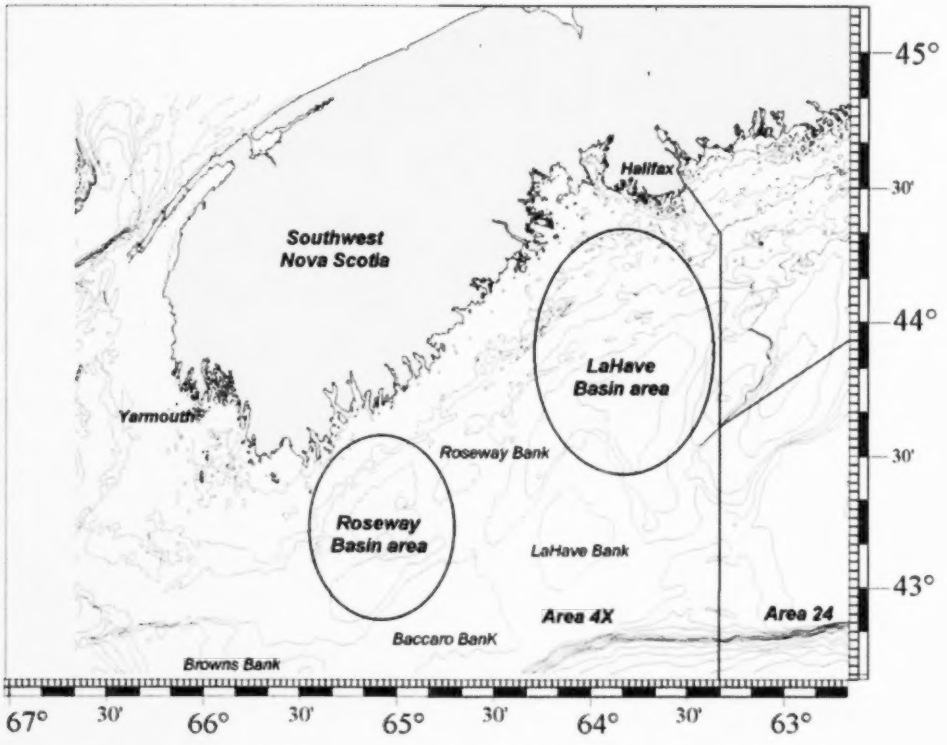


Figure 1. Snow crab fishing Area 4X (NAFO 4X) off southern Nova Scotia.

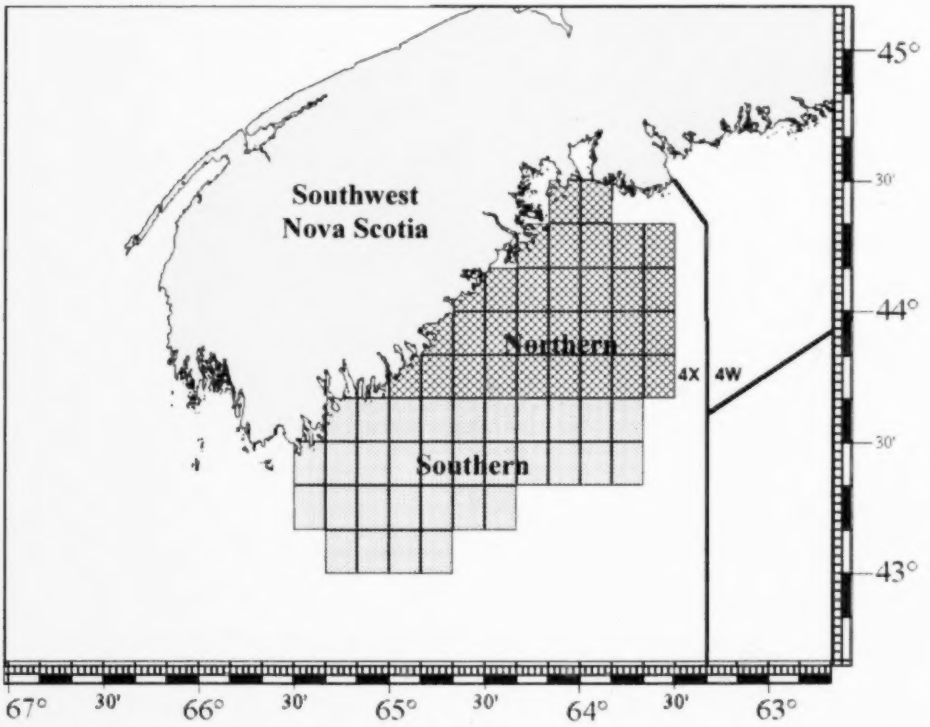


Figure 2. Grids fished during the 2002 trap survey in Area 4X.

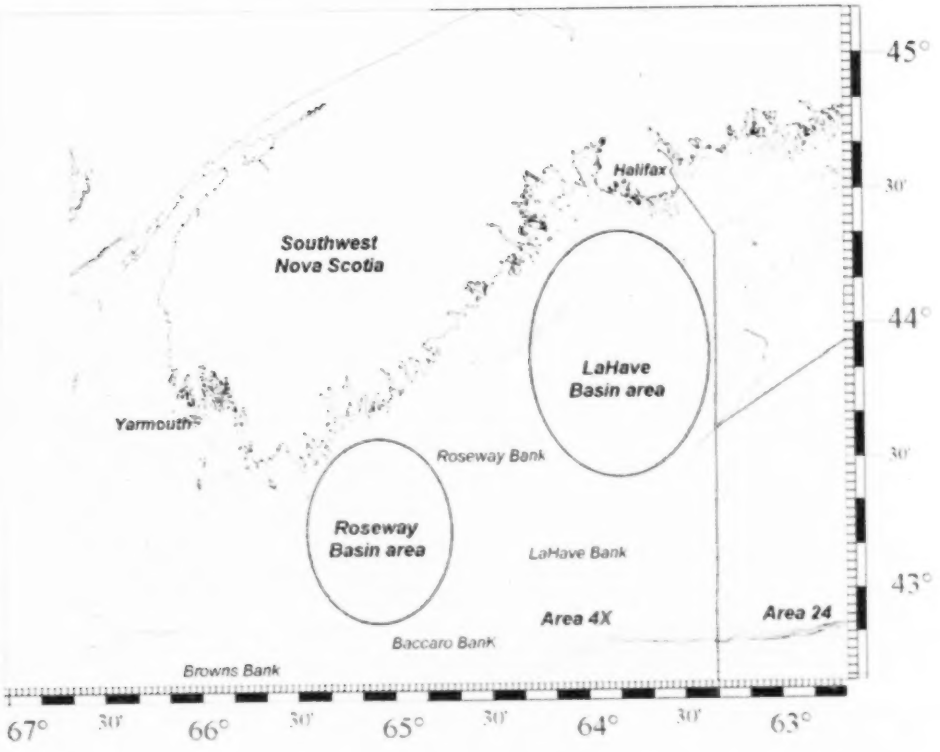


Figure 1. Snow crab fishing Area 4X (NAFO 4X) off southern Nova Scotia.

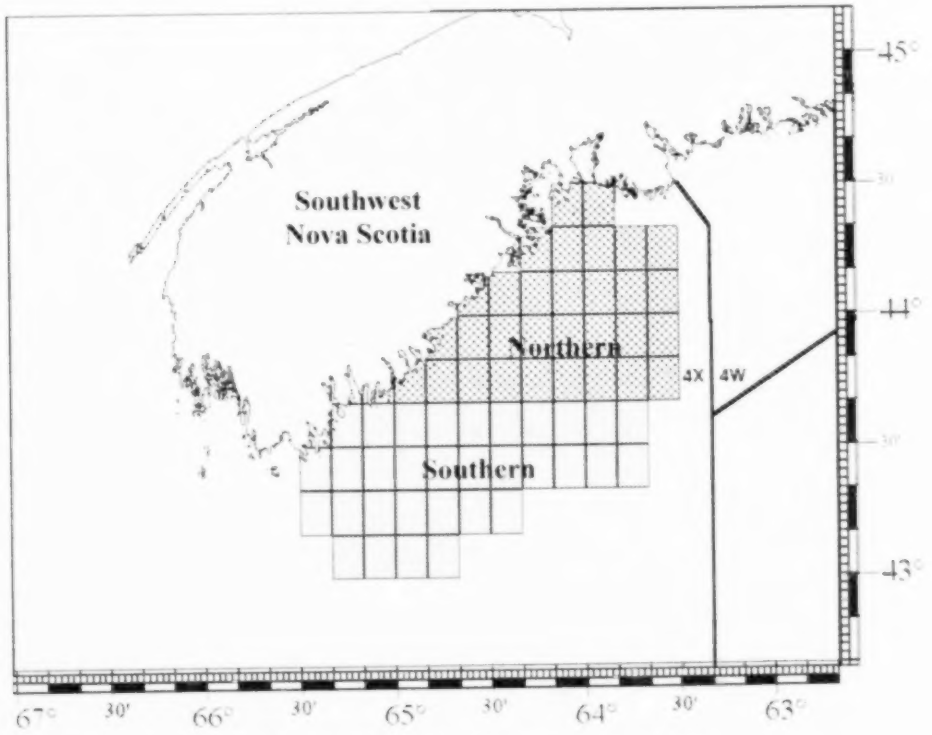


Figure 2. Grids fished during the 2002 trap survey in Area 4X.

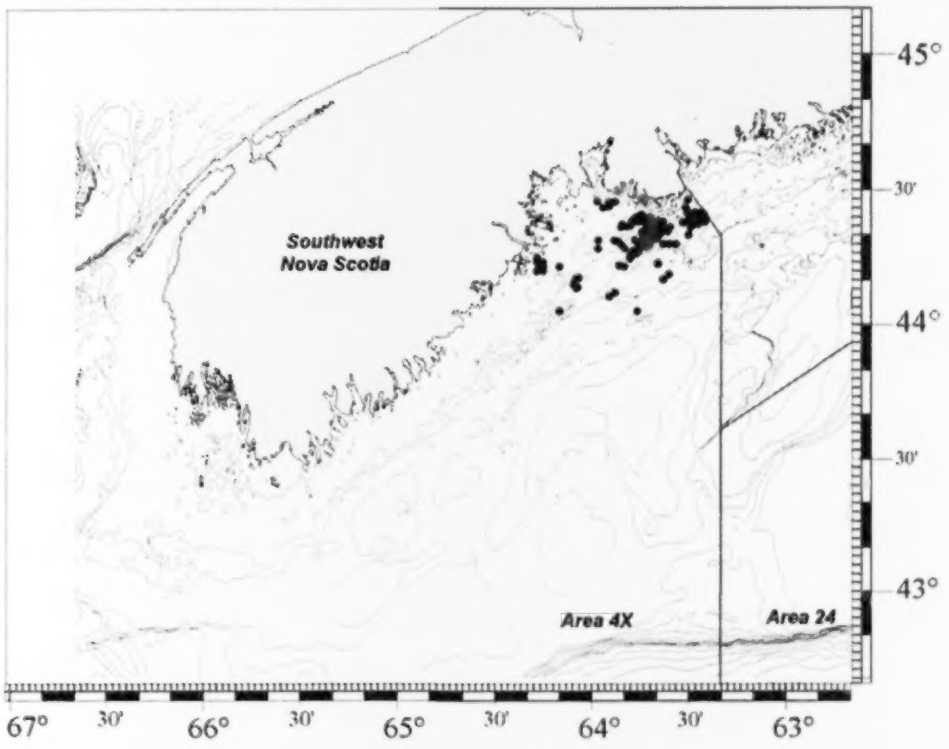


Figure 3. Reported logbook positions in 2001/02.

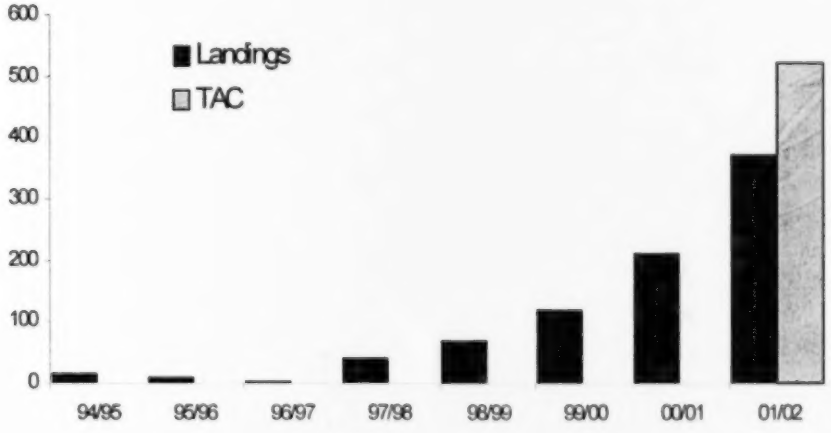


Figure 4. Seasonal snow crab landings (t) in southwestern Nova Scotia from 1994 to 2002.

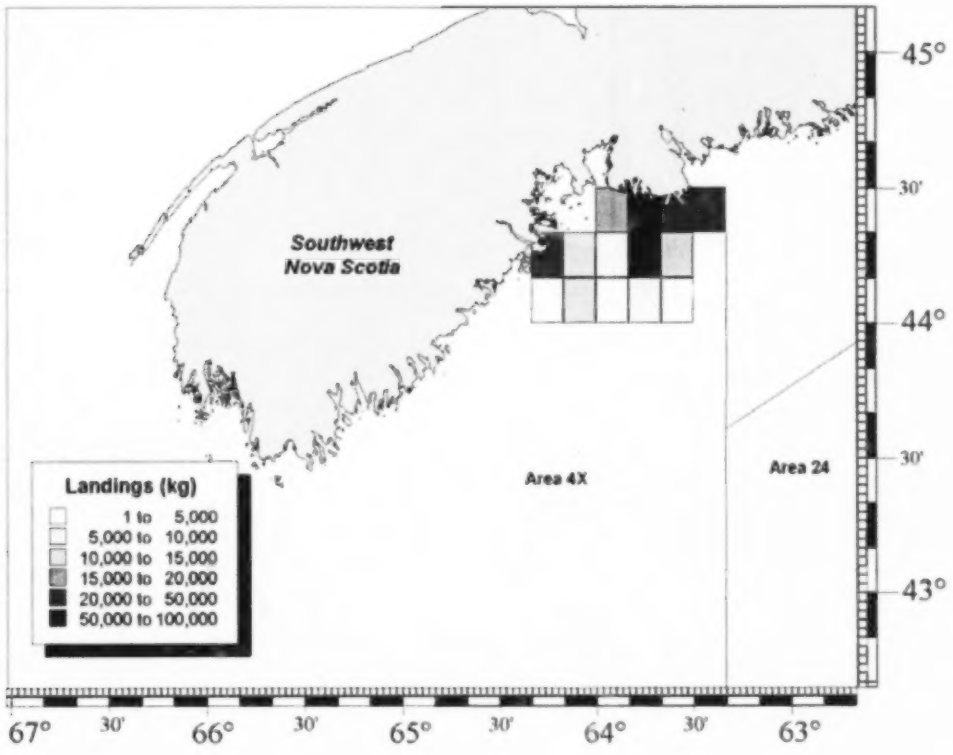


Figure 5. Distribution of snow crab landings for Area 4X during the 2001/02 fishing season.

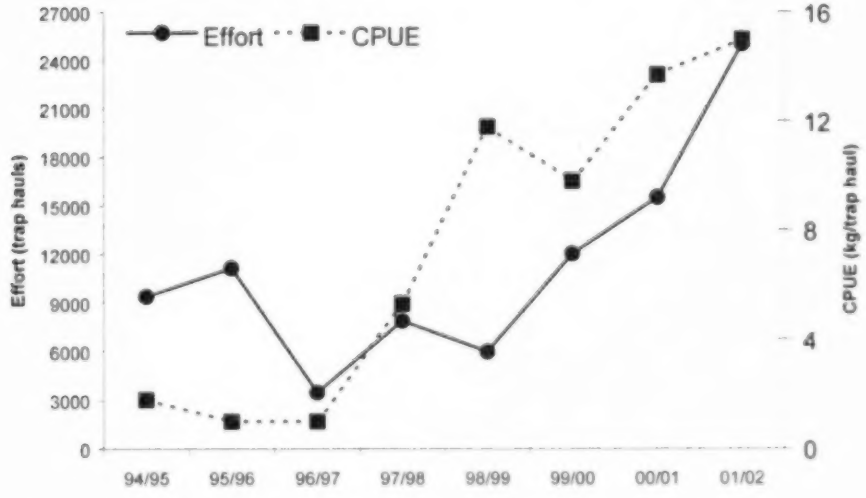


Figure 6. Fishing effort and CPUE for snow crab in Area 4X from 1994 to 2002.

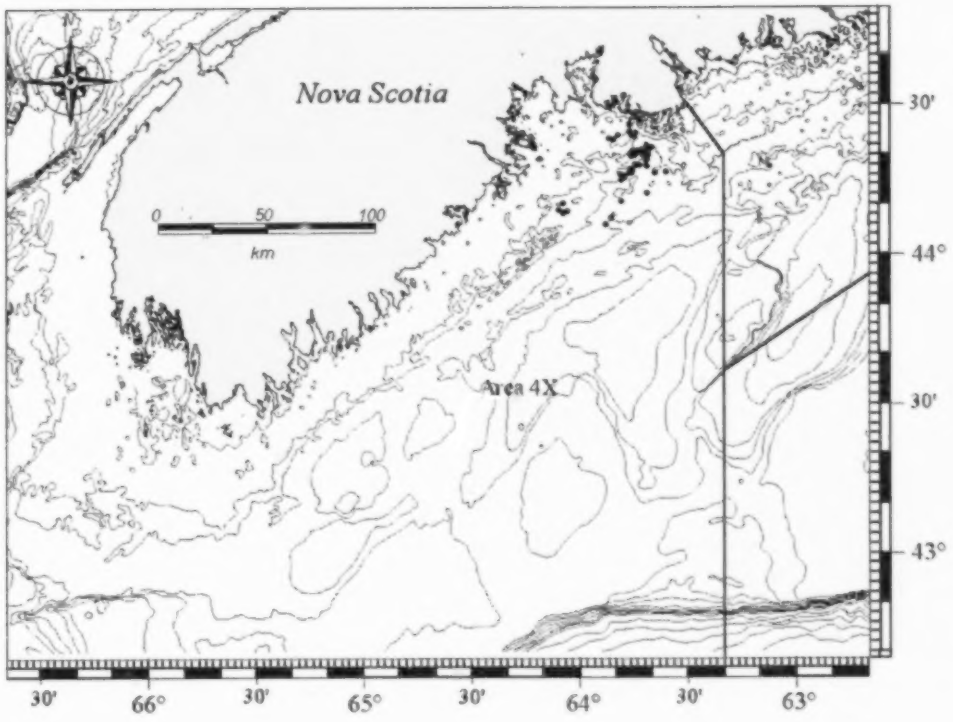


Figure 7. At-sea observer positions for Area 4X.

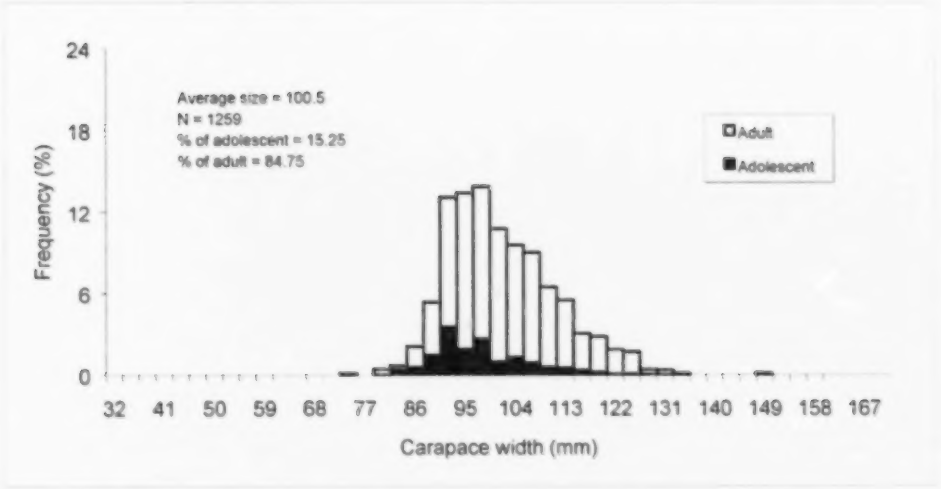


Figure 8. Snow crab size frequency distribution from the at-sea sampling (traps) in 2002 carried out in Area 4X.

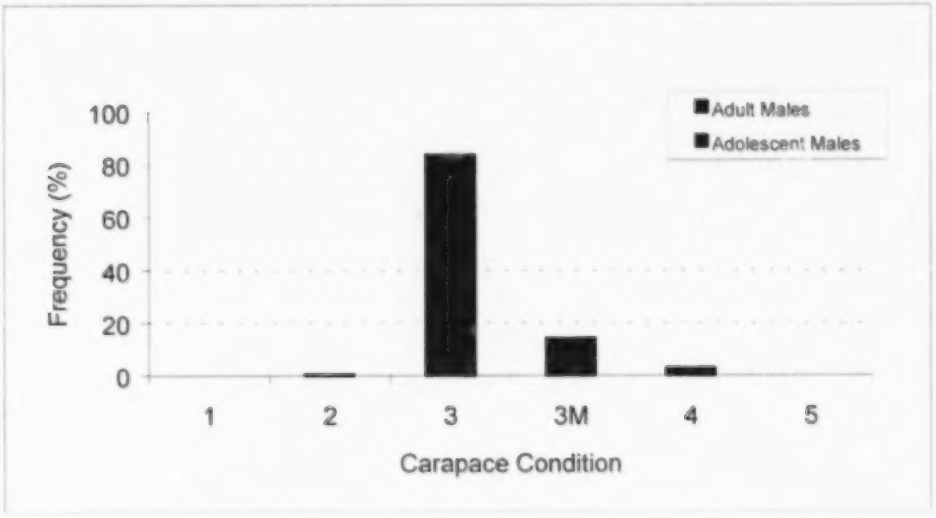


Figure 9. Shell conditions of snow crab captured in the at-sea sampling (traps) in 2002 carried out in Area 4X.

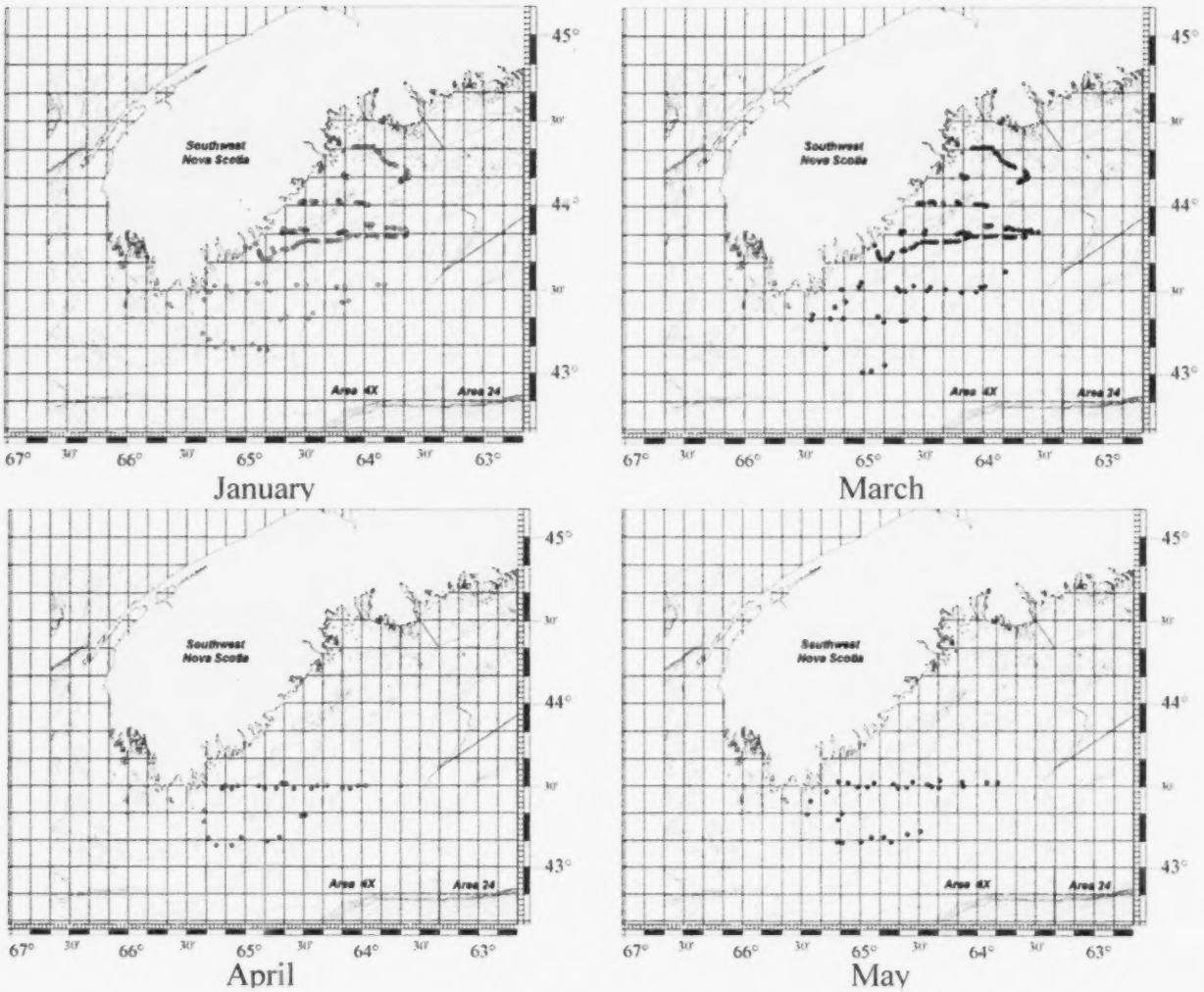


Figure 10. Monthly trap survey positions from the 2002 trap survey in Area 4X.

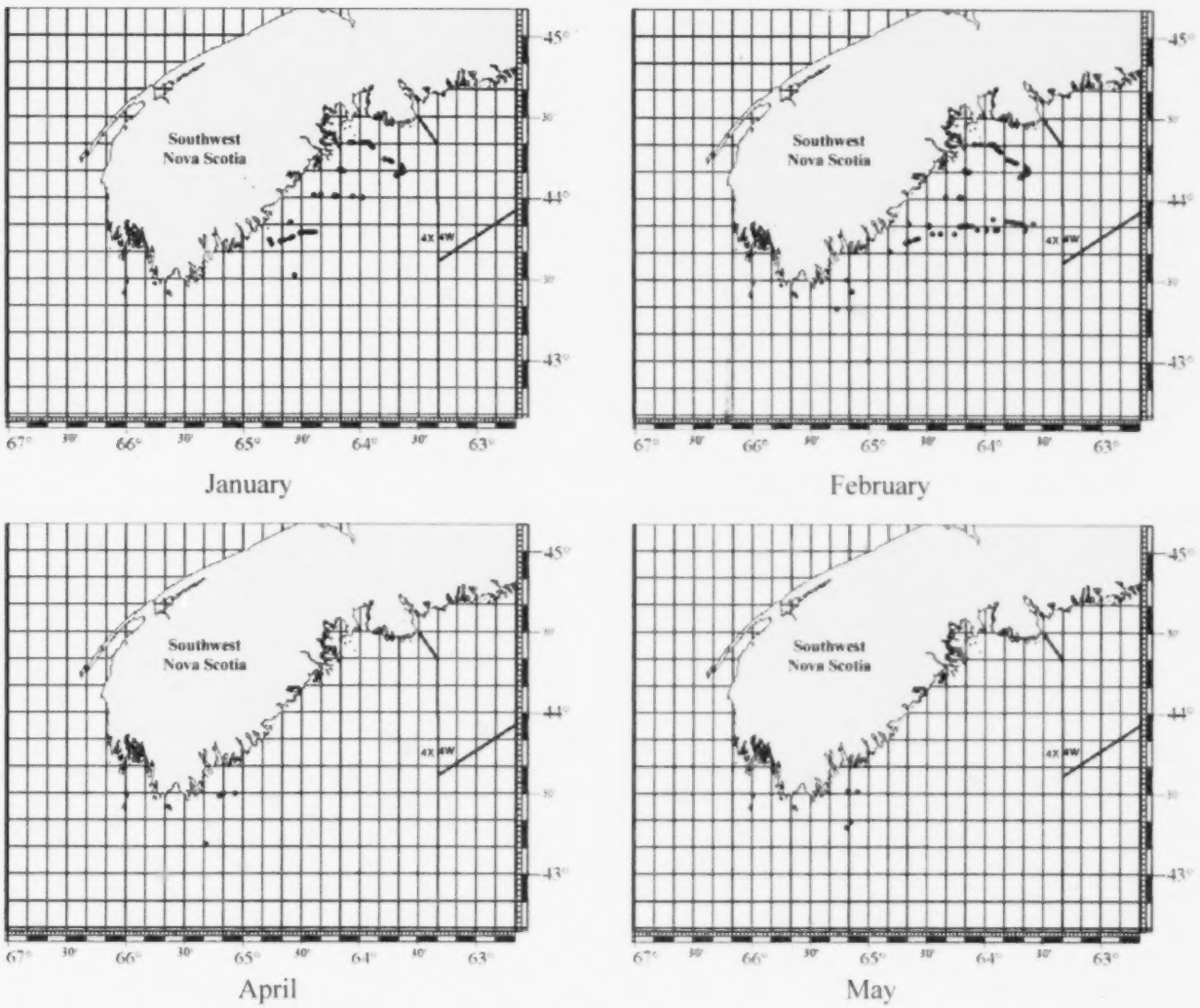
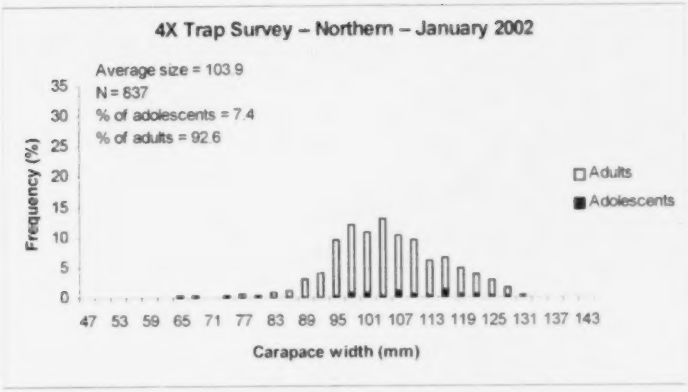
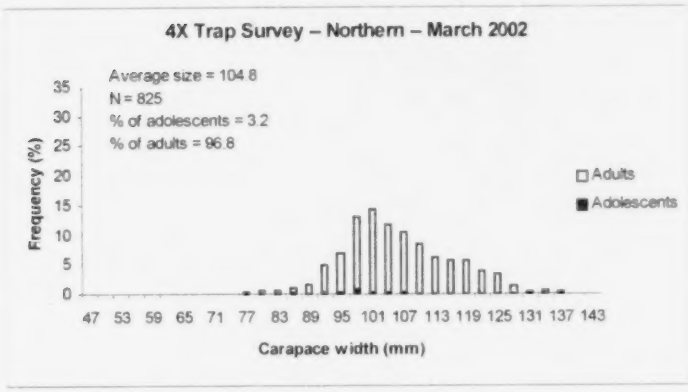


Figure 11. Trap locations of snow crab captured during the 2002 trap survey in Area 4X.


4X Trap Survey – Northern – January 2002
Average size = 103.9
N = 837
% of adolescents = 7.4
% of adults = 92.6
Adults
Adolescents
Frequency (%)
0 5 10 15 20 25 30 35
47 53 59 65 71 77 83 89 95 101 107 113 119 125 131 137 143
Carapace width (mm)


4X Trap Survey – Northern – March 2002
Average size = 104.8
N = 825
% of adolescents = 3.2
% of adults = 96.8
Adults
Adolescents
Frequency (%)
0 5 10 15 20 25 30 35
47 53 59 65 71 77 83 89 95 101 107 113 119 125 131 137 143
Carapace width (mm)

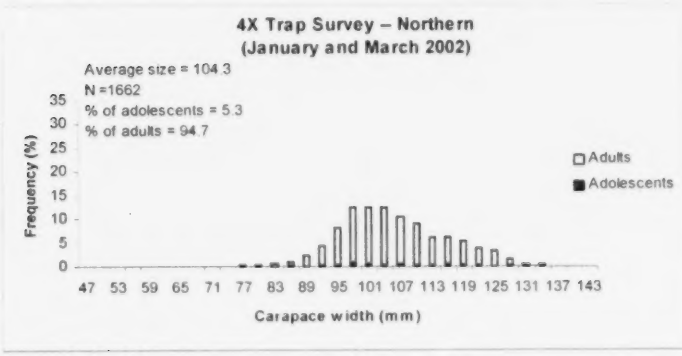
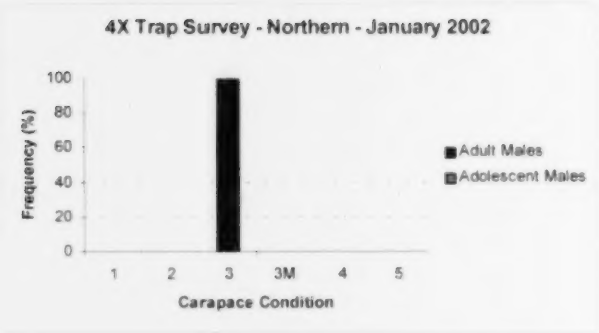
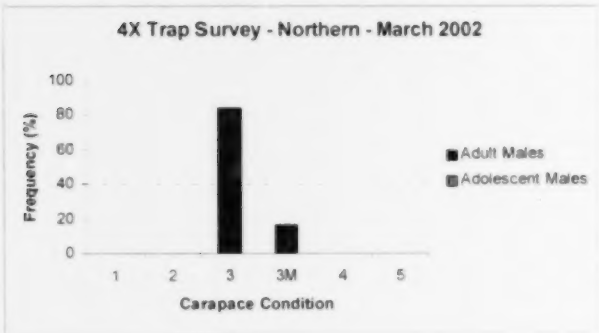
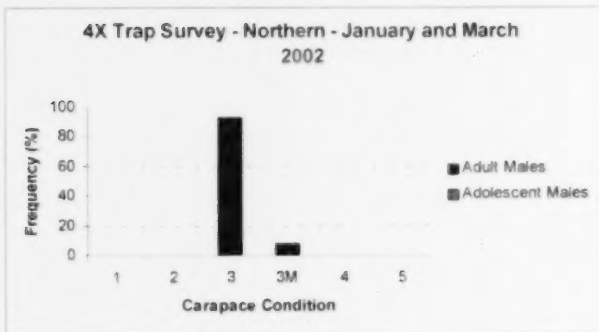

4X Trap Survey – Northern
(January and March 2002)
Average size = 104.3
N = 1662
% of adolescents = 5.3
% of adults = 94.7
Adults
Adolescents
Frequency (%)
0 5 10 15 20 25 30 35
47 53 59 65 71 77 83 89 95 101 107 113 119 125 131 137 143
Carapace width (mm)

Figure 12. Snow crab size frequency distributions from the 2002 trap survey carried out in the northern portion of Area 4X.







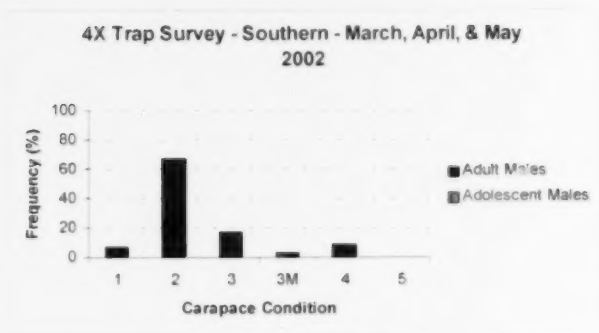


Figure 13. Shell conditions of snow crab captured in the 2002 trap survey in Area 4X.

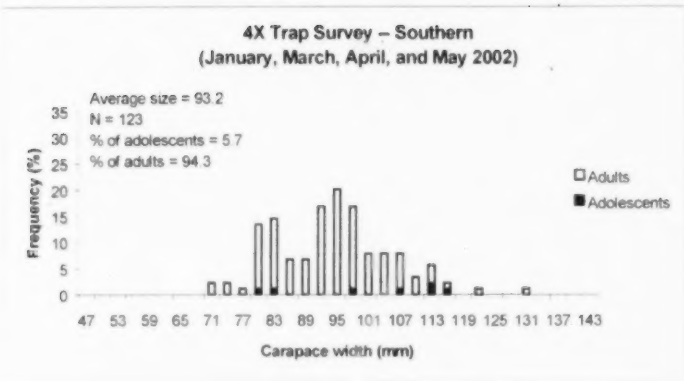


Figure 14. Size frequency distributions of snow crab from the 2002 trap survey carried out in the southern portion of Area 4X.

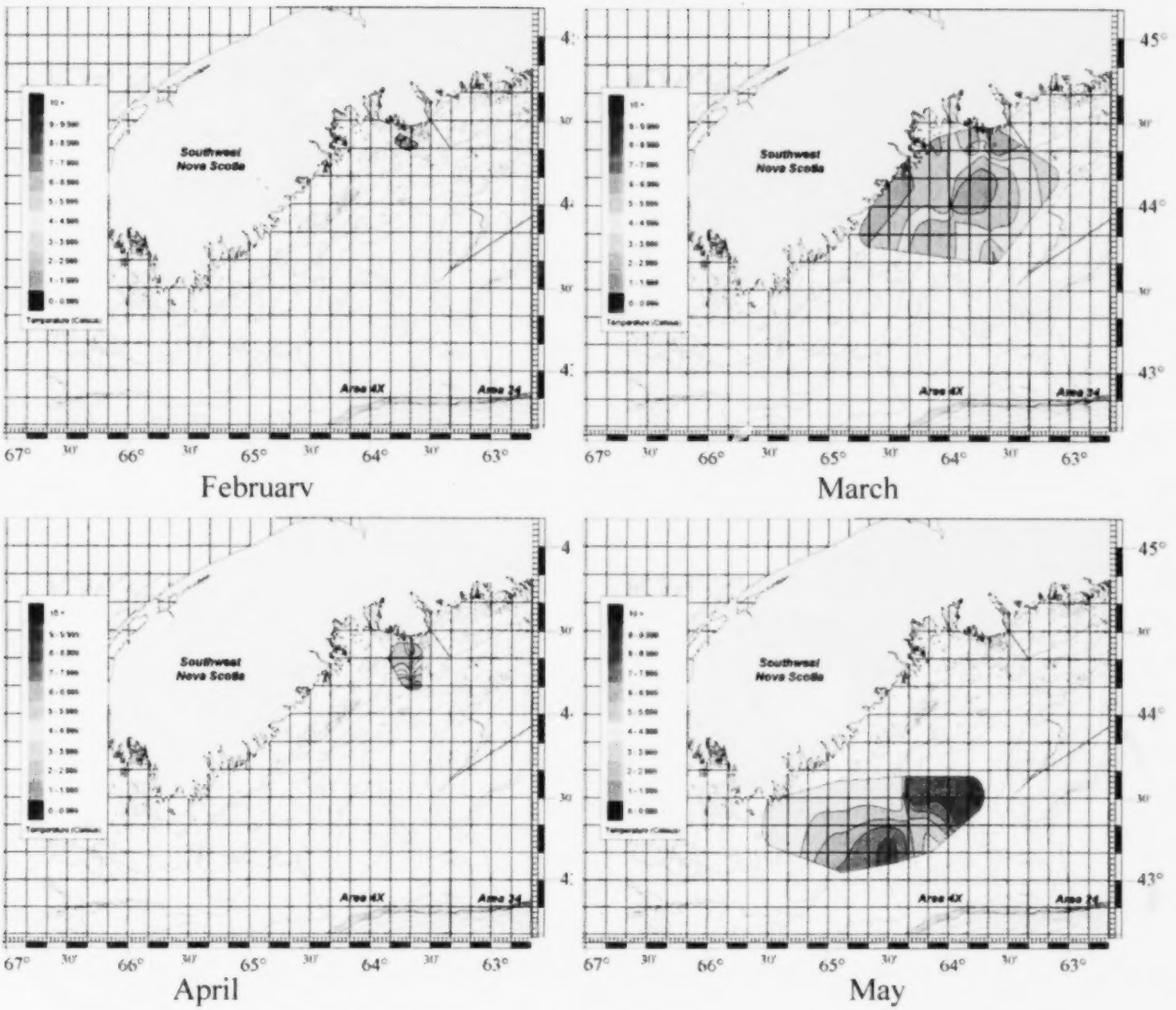


Figure 15. Monthly temperature contours of the 2002 trap survey conducted in Area 4X.

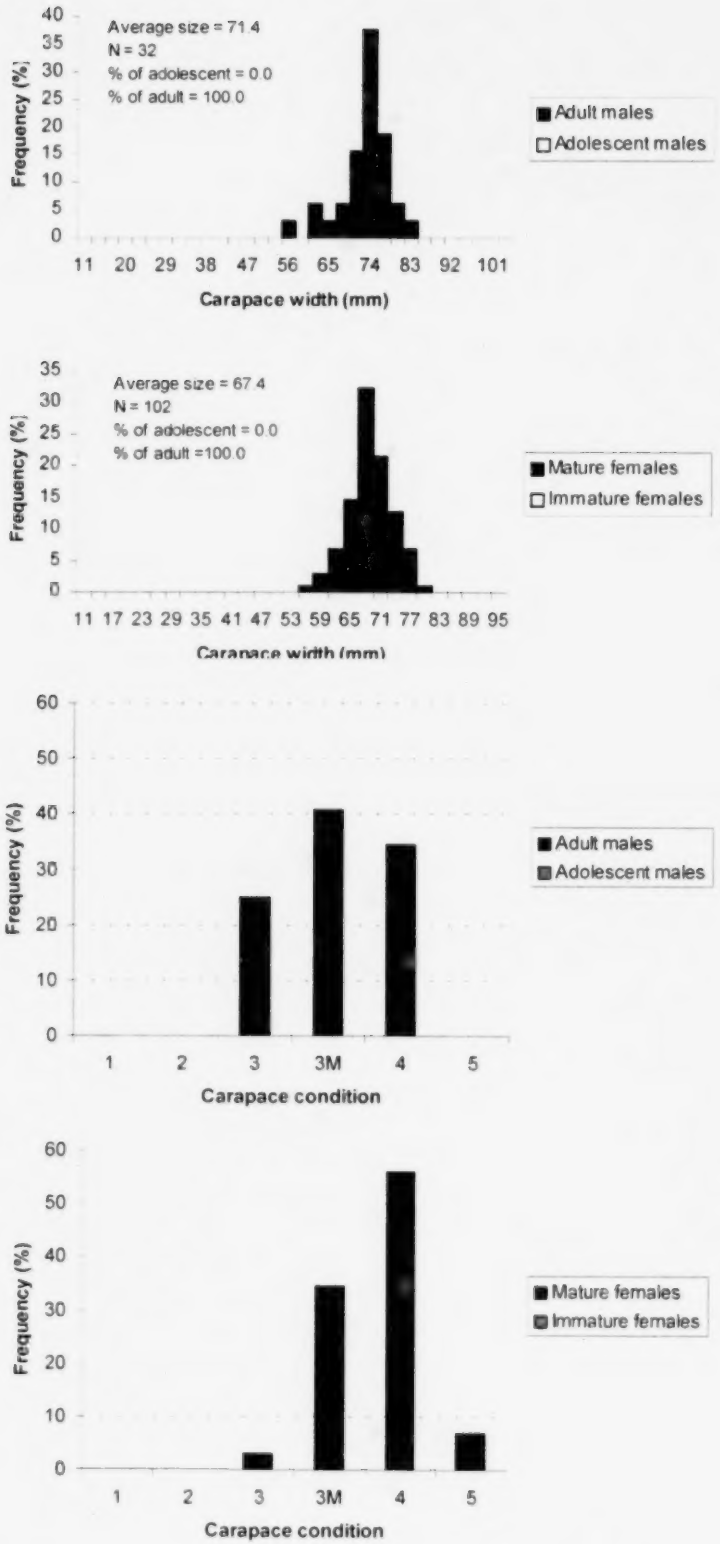


Figure 16. Size frequency distributions and shell conditions of snow crab from the biological sampling carried out in Area 4X.

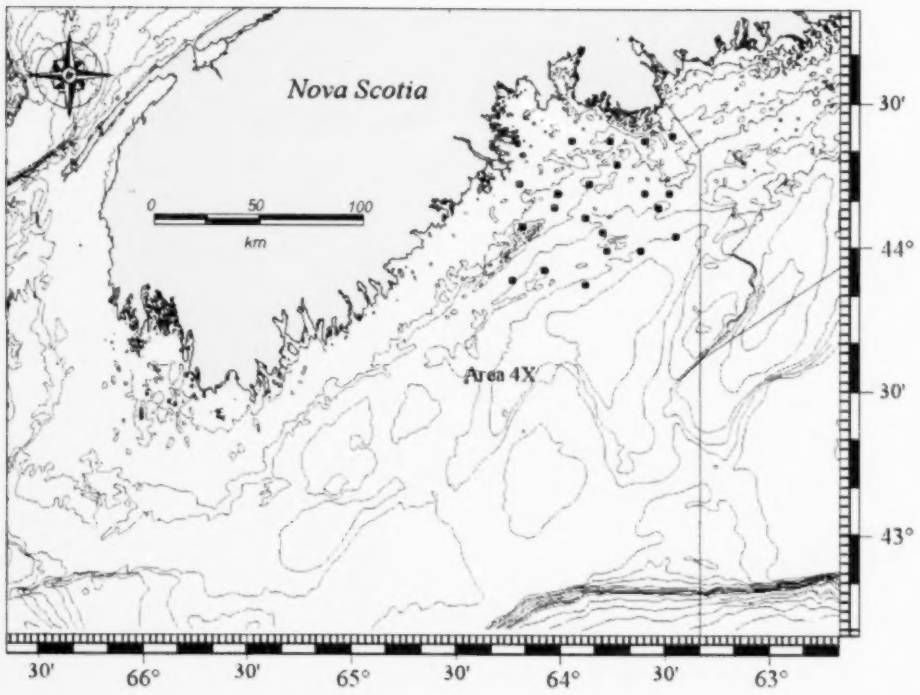


Figure 17. Trawl survey stations in Area 4X.

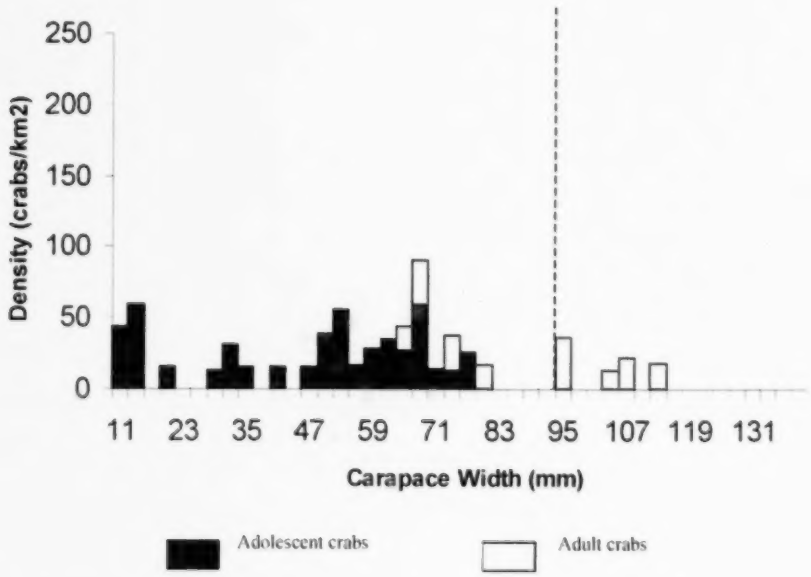


Figure 18. Size frequency distribution of snow crab from the trawl survey in Area 4X.

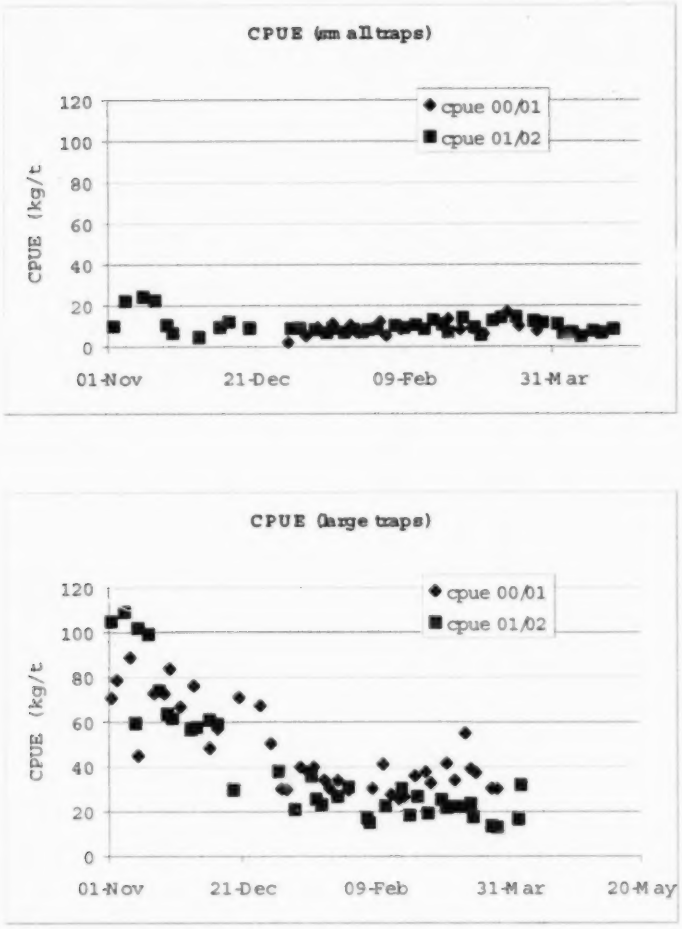


Figure 19. Snow crab CPUE by trap type in Area 4X for the 2000/2001 and 2001/2002 fishing seasons.

Appendix 1

Classification of carapace stages based on carapace condition, durometer reading and corresponding approximate age after terminal molt (Moriyasu et al. 1998).

Category	Stage	Durometer reading	Carapace condition	Approximate age after terminal molt
New soft	1	< 68	brightly colored, iridescent, soft, no epibionts, chelae easily bent.	0-5 months
Clean	2	variable	brightly colored, some iridescence, may have epibionts, chelae not easily bent	5 months- 1 year
Inter-mediate	3	> 68	dull brown dorsally and yellow-brown ventrally, no irridescence, shell abrasion evident, epibionts.	8 months -3 years
Old	4	> 68	carapace very dirty but hard, decay may be present at leg joints, epibionts removable at processing plant.	2 - 5 years
Very old	5	variable	carapace very dirty and may be soft (durometer reading < 68), progression of decay may be evident, epibionts not removable at processing plant.	4-6 years

Appendix 2

Re: Snow Crab 4X Research Survey

Temporary, snow crab access is being provided within the 4X area for the 2001/2002 season. Access will be based on a review of proposals submitted by interested parties to conduct a survey to determine snow crab distribution and gather biological information on areas not fully exploited by the existing fleet. During the season, when not doing the survey, the successful candidate(s) may fish their quota anywhere within the 4X area.

This letter is a request for submissions to conduct the survey. There are approximately 60 grid sections to be surveyed during the season and no single licence holder is expected to complete all grids. However, within your proposal you should indicate the number of grids that you are willing to complete.

Your proposal should also include the total estimated costs that will be incurred. This is a business case and should include the allocation of snow crab you feel is required to make this a viable survey. Some of the costs to be included in your proposal are vessel cost, fuel, supplies, observer costs, wages, etc. It should be noted that any snow crab that is caught and retained within the survey would be included in the overall vessel quota.

All proposals must be received by 1600 hours November 30, 2001. A committee comprised of DFO staff and industry representatives will evaluate your proposal and will notify you of the successful candidate(s).

A Joint Project Agreement between DFO and the fishermen will be required to cover the survey protocols. The minimum protocols required are attached for your review.

The successful candidate(s) will continue to receive access after this season upon successful completion of the survey and if stock abundance permits. If you have any questions, please do not hesitate to contact Ian Marshall or myself.

Yours truly

Michael Eagles

Appendix 2 (continued)

SCIENCE RESEARCH SURVEY – 4X
SCIENCE AND MANAGEMENT PROTOCOL

AREA TO BE SURVEYED AND DURATION

The following area is to be surveyed between November 1, 2002 and the end of May, 2002: 4X between the La Have area and Roseway Basin area.

VESSELS

The vessel(s) must be registered as a fishing vessel with DFO and have a class 2 licence. Indicate the name and size of vessel to be used.

SETS

The areas will be divided into 10-mile square sections. There is a minimum requirement for five trap hauls within each section. This will be done a minimum of 2 times and at least one month apart. A minimum 24-hour soak time for each trap. Science to provide T°C probes (thermographs).

REPORTING REQUIREMENT

Reporting to include for each trap – date set, date fished, soak time, position of trap, description of catch – ie. Snow crab, jonah crab, others, number, carapace size and weight of catch, sex of crab.
Additional reporting requirements include time of landing (offloading), location (port) of landing, accurate weight of catch landed (offloaded).

TAGGING

If there is a concentration of crab – ie. 50 crabs per trap (for a section) – tagging will be a requirement.

SAMPLING

Sampling of at least 40 randomly selected animals per section or all if less than 40 animals, will be supplied to Science. The majority of animals in this sample should be female and undersized (<95 mm) males, with a few randomly selected adult males. Landings of females and undersized males will be permitted for the purpose of science measurement. All other females and undersized males must be returned to the waters.

AT-SEA OBSERVER COVERAGE

There is a minimum requirement of at-sea observer coverage in the commercial fishery. However, sampling requirements must be met by using a DFO approved sampler that may be supplied by the at-sea observer company.

DOCKSIDE MONITORING

There will be 100% dockside monitoring.

HAIL REQUIREMENTS

There is a requirement to hail out to a dockside monitoring company that has been approved or certified with the Department of Fisheries and Oceans prior to leaving port and hail-in from sea 2 hrs. prior to returning to port. The hails are to include licence number, vessel registration number, captain's name, time leaving port, time and location expected to land and offload and accurate amount of catch on board.

SCHEDULE OF WORK

A schedule is to be included in proposal.

PERFORMANCE GUARANTEE

A performance guarantee that the work will be completed is to be included. The type of guarantee must be satisfactory to DFO.